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CONCRETE TOOL IMMOBILIZING CIRCUIT

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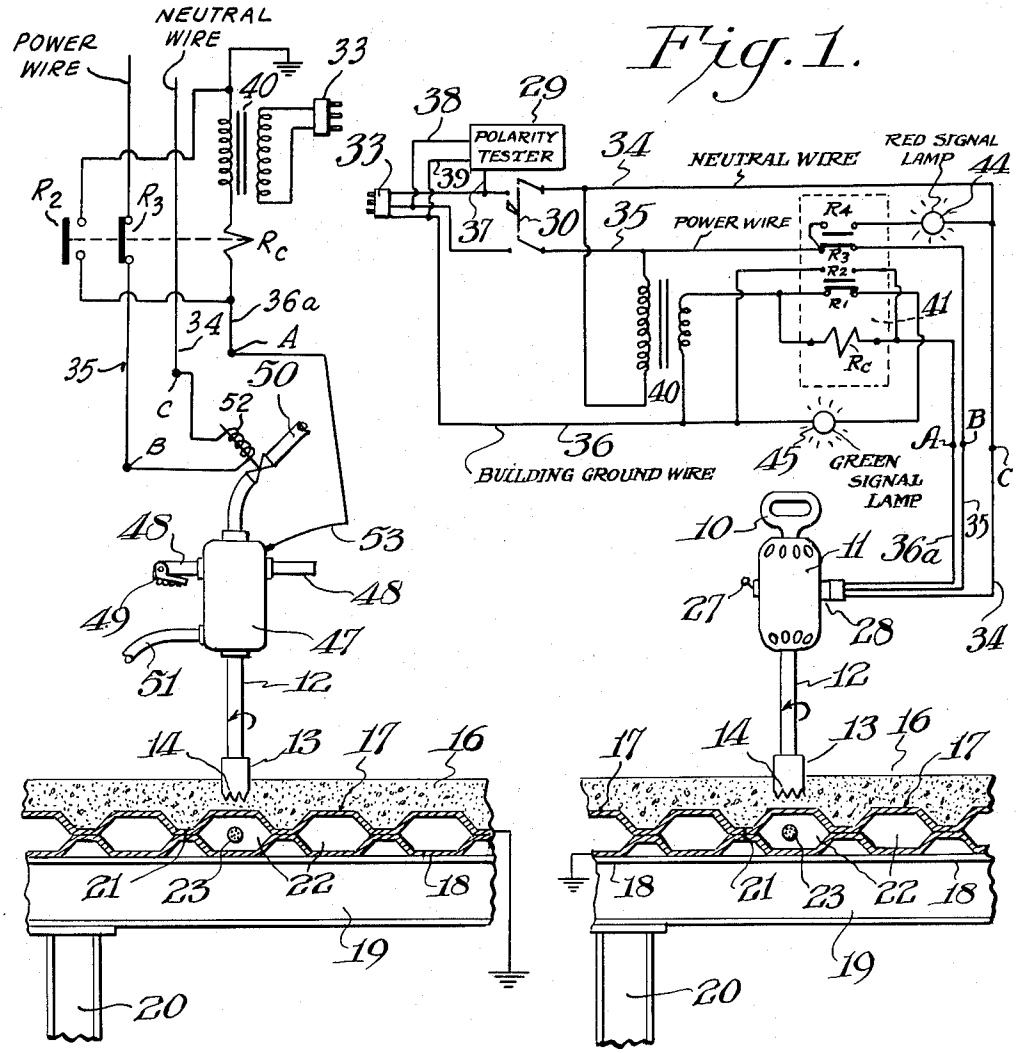


Fig. 1.

Fig. 2.

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CONCRETE TOOL IMMOBILIZING CIRCUIT

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This invention relates to a concrete tool immobilizing circuit and particularly to a concrete tool immobilizing circuit intended for use in conjunction with concrete cutting tools which are employed to pierce concrete up to but not beyond grounded metallic structures embedded within and/or supporting the concrete.

Recently, extensive use has been made of metal support structures which have been employed as the under support for the concrete floors of industrial and commercial buildings, the support structures having a corrugated cross section which contributes strength and stiffness and also define, by association with similar structures disposed in opposition thereto, enclosed raceways which may be conveniently utilized for the housing of electrical power cables, telephone cables and the other wiring and piping necessary for the provision of complete service facilities within the building. An advantage of the metal support structures described is that forms for the casting of concrete flooring are entirely eliminated, the concrete being cast directly over the top surface of the top support structure, which provides all of the support necessary for the concrete. The support structures are themselves supported at intervals by the steel building framework, comprising the customary horizontally disposed I-beams or channel beams which are themselves supported by vertical steel members of the same type. It is the usual practice to ground electrically the building framework and consequently the support structures are likewise electrically grounded by their direct contact with the framework. For conventional buildings it is the usual practice to cast 3" or 4" of concrete over the upper support structure, thus providing a strong, wear-resistant floor economically and expeditiously.

A serious problem in connection with the use of the support structures hereinabove described is that it is frequently necessary to drill through the concrete superposed on the upper support structure in order to make connections with the power cables or communication wires enclosed within the raceways defined by the support structures. Relatively heavy electrical, hydraulic or pneumatic drills are commonly employed for this purpose and, because of the high resistance of concrete to drilling, it is often impossible for the drill operator to determine when he has cut away all of the concrete and is about to drill into the metallic support structure. Ruled gages of various types might be used to give an approximate indication of the degree of penetration of the tool working head through the concrete; however, these are disadvantageous because the thickness of the concrete often varies considerably at different locations, visibility is impaired by concrete chips and debris thrown up by the drill and, furthermore, the drill head is usually cooled with a constantly running stream of cooling water which bathes the area being worked with water. The use of cooling water creates another serious problem in that, if the support structure is pierced by the tool and the raceway laid open water, of course, pours into the raceway, short circuiting electrical wiring therein or otherwise damaging it and sometimes overflowing through the loosely fitted edges of upper and lower support structures to leak from the ceiling onto the floor below. An even more serious problem than either of the foregoing is, if a raceway is unknowingly entered by the operator, his tool may cut through the insulation of electrical conductors housed therein and give him a severe or fatal electrical shock.

A primary object of this invention is to provide a concrete tool immobilizing circuit which is adapted to permit unhindered drilling or breaking of the concrete up to the point where the surface of metallic support members embedded therein is contacted, and then shutting off the power to the tool automatically so that further penetration is halted. Another object of this invention is to provide an economical, light-weight immobilizing circuit for concrete piercing tools which eliminates the possibility of electrical shock injury to operating personnel. Another object of this invention is to provide a concrete tool immobilizing circuit which eliminates the possibility of costly damage to electrical raceways, water service pipes, gas service pipes or chemical fluid service pipes which may be embedded in the concrete or housed within raceways covered by the concrete. Yet another object of this invention is to provide a simple immobilizing circuit for concrete-penetrating tools, such as drills, breakers and like apparatus. The manner in which these and other objects of this invention are obtained is described in detail hereinbelow and illustrated in the accompanying drawings, in which:

Fig. 1 is a schematic representation of a preferred embodiment of one immobilizing circuit according to this invention shown in conjunction with a conventional electrical concrete drill, which latter is portrayed in cutting position part way through a concrete floor laid over steel support structures of commercially available design, and

Fig. 2 is a schematic representation of a hydraulic or pneumatic powered tool provided with auxiliaries adapting it to control according to this invention.

Generally, the tool immobilizing circuit of this invention comprises an electrical relay, and powering facilities therefor, such facilities being subordinated to the circuit in a manner which is adapted to disconnect the power supply from the tool when the working head establishes electrical ground connection through the metal support structures embedded in and/or supporting the concrete or through any raceways, service pipes or the like covered by the concrete. It will be understood that various electrical signal devices have heretofore been devised which generate a proximity signal depending on variation in resistance as a function of the thickness of earth covering a pipe to be excavated, such as that described in U. S. P. 2,131,291, for example, or upon variation in capacitance depending on the clearance between a crane boom and an adjacent high voltage power line, such as that shown in U. S. P. 2,615,969; however, neither of these constructions is suited to the purposes of this invention.

Referring to Fig. 1, a preferred embodiment of this invention as applied to an electrically powered tool comprises the circuitry shown, several elements of which are optional as will hereinafter be described in detail. The electrical tool **10**, for purposes of representation, is shown as an electrical drill which is provided with a driving motor **11** direct-connected to a rotatable drill shaft **12**. The drill shaft is provided at its lower end with an annular form drill head **13**, provided at the bottom periphery with a plurality of sharpened concrete-piercing serrations **14**. With this type of drill it is possible to rapidly cut a smooth hole 2¾" in diameter or greater through thick concrete, the concrete core severed from the floor being received within the hollow recess of drill head **13** as a unitary cylindrical plug which can be readily removed by the drill operator with his fingers after the drilling operation is completed. Since considerable heat is liberated in the course of the drilling operation, it is customary to flood the drill head with a water hose (not shown) so that heat is dissipated and dust kept down.

As shown in the drawing, the metal support structures hereinabove mentioned for the concrete comprise upper members **17** and lower members **18** disposed in opposition to members **17**, the concrete floor **16** and both upper and lower support structures being supported by horizontally disposed girder **19** and vertical steel member **20** which latter constitute parts of the building framework which is connected as a whole to electrical ground. For convenience in handling and from weight considerations, the corrugated support structures **17** and **18** are usually formed in sizes defining not more than four half-raceways, the edges of adjacent units in the drawing being indicated in abutment at **21**. The oppositely disposed support structures **17** and **18** thus define open raceways **22** which run the full length of the support structures and continue on between other support structures oriented similarly in an endwise direction, thus providing convenient service facilities to all points of the floor above. For the purposes of this description, an electrical power cable **23** is shown in end section in the raceway immediately below the operating drill head **13**, it being assumed that it is desired to establish an electrical connection therewith from the floor above. Drill **10** is conventional in design, the motor being provided with a manual power switch **27** and a female power socket **28**.

Turning now to the immobilizing circuit of this invention, all of the electrical circuitry shown, except the polarity tester **29**, the use of which is optional, is preferably housed in a box, not shown, with the signal lights open to the view of the operator and switch **30** accessible to him. The power for the circuit and also for tool **10** is derived through the 3-wire male plug **33** which is adapted to engage with a conventional 115 v. A. C. receptacle or other alternating current supply corresponding to the design characteristics of the tool. The three conductors running from plug **33** consist of neutral wire **34**, power, or "hot," wire **35** and building ground wire **36**.

Polarity tester **29**, when used, is tapped in to neutral wire **34**, power wire **35** and ground wire **36** by conductors **37**, **38** and **39**, respectively in the usual manner known to persons skilled in the art, and therefore not further described herein. Switch **30** in circuit with wires **34** and **35** is a conventional on-off double pole switch. Control power for the circuit of this invention is derived through step-down transformer **40**, the primary winding of which is connected across neutral wire **34** and power wire **35**, and the secondary of which is connected on one side to ground wire **36** and on the other side to one of the relay contacts R_1 of relay **41** which is represented as an entity within the box shown in broken line representation in the drawing. Transformer **40** is adapted to step down 115 v. supply current to about 8 v. A. C. on the secondary winding terminals.

Automatic reset control relay **41** is provided with four sets of relay contacts, these being R_1, R_2, R_3 and R_4, and, in the design described in detail herein, is of the overlapping contact type, a suitable construction being an Allen-Bradley Bulletin 700, type BZ–220, 6 v. coil, 60 cycle device, wherein contacts R_2 and R_4 close prior to the opening of contacts R_1 and R_3. Relay **41** is provided with the usual relay coil R_c, which is adapted to operate all of the relay contacts R_1–R_4 inclusive.

As shown in the drawing, relay contacts R_1 establish the electrical circuit between the power side of the secondary of transformer **40** and ground **36**, through green signal lamp **45**, one lead of relay coil R_c being tapped in between the high potential side of the secondary winding and the relay contacts, while the other lead for R_c is connected to one of the contacts R_2. The other contact of R_2 is connected to ground **36**. Relay contacts R_3 are connected in circuit with power wire **35** running to motor **11**, while a second connection to the power side of R_3 leads to one contact of R_4. A red signal lamp **44** is connected between the other contact of R_4 and neutral wire **34**. A ground wire conductor **36***a* is provided between

motor **11** and the output side of relay coil R_c and the second contact of relay R_2.

In operation, the contacts of relays R_1–R_4 are normally in the position shown in the drawing, and are not operated in the reverse sense until drill head **13** makes contact with a grounding concrete support structure, at which time the control circuit immobilizes the motor of drill **10** by disconnecting the power supply therefrom. When all is in readiness for drilling, the operator throws switch **30** to closed position, which immediately establishes current flow through relay contacts R_1, thereby illuminating green signal lamp **45** which indicates visually that the transformer secondary control potential exists in proper magnitude for operation of the control circuit. The operator then closes motor switch **27** and drill head **13** commences to revolve and to cut away the concrete of floor **16**. When grounding contact between drill head **13** and support structure **17** is established, relay coil R_c is immediately energized by current flow through it from the upper terminal of the secondary of transformer **40** to ground through the drill bit and the grounded metallic flooring **17**, and relay contacts R_2 and R_4 are then closed while relay contacts R_1 and R_3 are simultaneously opened, the latter action occurring slightly after the closure of contacts R_2 and R_4. The relay thus provides a circuit around the drill bit connection to ground which prevents restoration of current flow through relay contacts R_3 to motor **11** by continuing ground connection of the relay coil R_c through contacts R_2 rather than through the drill head **13** and support structure **17**. At the same time red signal lamp **44** is illuminated, signaling the operator that the drill has come into contact with an embedded support structure, and green signal lamp **45** goes out, its circuit being opened by relay contacts R_1. Further drilling operation is thus rendered impossible and the operator can remove the drill by pulling it clear of the support structure **17**. Disengagement of the drill from the hole is sometimes facilitated by rotating the drill during pull-away, which can be easily accomplished by the operator upon momentary opening of switch **30**, which restores the relay contacts to the position shown in the drawing, and then closing the switch **30**, it being understood that drill head **13** must be first brought out of contact with support structure **17**, or the circuit will perform its immobilizing function again in the same manner above described. Switch **30** may desirably serve other purposes, in that the flow of a fault current occurring within motor **11** which permits current flow through coil R_c disrupts the power supply and also operates the signal lamps **44** and **45**, thereby giving notice to the operator that the equipment is not operating normally and that corrective measures should be taken. Also, switch **30** is preferably opened before the operator wets his hands or clothing by contact with the cooling water in succeeding operations to thereby clear high potentials from the entire circuit and protect him from light electrical shocks due to a considerable difference in potential between the apparatus and ground. After the core is completely cut from the concrete floor **16**, the drill is lifted away and the core is removed from the hole. Cooling water in the hole and in the surrounding area is mopped up and removed, thus exposing the top side of support structure **17** for the cutting of a hole through the metal, which is conveniently accomplished by the use of a light weight metal circle cutter which can be operated under the visual control of the operator without danger of cutting into the insulation of enclosed cable **23**, flooding raceway **22** with water or otherwise risking danger from injury due to electrical shock, or damage to electrical conductors mounted within the raceways.

It will be understood that the circuit hereinabove described in detail is somewhat more elaborate than is necessary to perform the principal functions served by the control circuit of this invention, although operating experience has indicated that all of the features are desirable for best results. However, if desired, the signal lamps

44 and 45 may be dispensed with, together with the relay contacts associated herewith, in which case a two-pair contact relay is entirely satisfactory for the purposes contemplated. As previously mentioned, polarity tester 29 can also be dispensed with; however, its utilization is preferred from the safety standpoint.

The control circuit hereinabove described is equally applicable to pneumatically or hydraulically powered tools, or to tools powered by any given single phase or polyphase electrical circuit, by relatively simple adaptation such as that shown by way of example in Fig. 2. In this view the tool 47 is of conventional design incorporating gripping handles 48, on-off operating control hand lever 49 and powering fluid supply line 50 and powering fluid exhaust line 51. The tool is provided with a drill shaft 12 and serrated drill head 13, designated by the same reference numerals employed for the corresponding elements of Fig. 1. The only changes required to adapt the tool of Fig. 2 to control by the circuit of this invention is to interpose in fluid supply line 50 a solenoid valve 52 of conventional design having leads which are connected in the proper convention to points B and C in power line 35 and neutral line 34, respectively, electrical tool 10 being of course disconnected from the circuit by removal of the plug engaging with power socket 28. In addition, an electrical grounding lead 53 securely attached to the metal frame of tool 47 and in electrical circuit with drill shaft 12 and drill head 13 is provided, which is connected with the control circuit grounding wire 36*a* at point A. Relay R_C, contacts R_2 and R_3 and the associated electrical control circuitry of Fig. 1 are denoted by the same reference numerals in Fig. 2, the operative connection of the relay with the contacts being indicated in broken line representation. It will be understood that the operation of the tool of Fig. 2 is identical with that already described with reference to Fig. 1, except that the control is now imposed through the agency of solenoid valve 52. It will be apparent to persons skilled in the art that a solenoid type control such as that which has been above described may be advantageously employed to control special single or polyphase electrically powered tools, as distinguished from pneumatic or hydraulic tools, in a manner well known to the art and therefore not further described herein.

The immobilizing circuit of this invention is intended for use with electrically non-conductive floors and, if iron filings or other conductive materials are employed as aggregates, the device will, of course, not be applicable. Ordinarily, where support structures of the design hereinabove described are used, no metal reinforcing is utilized in the concrete floors and therefore the possibility of grounding from this cause is absent. It will be understood, however, that this invention is still useful where grounded metal reinforcing is embedded in the concrete because, until the fact is verified that reinforcing instead of service conduit is exposed, the possibility of damage still exists. It is furthermore desirable to cut away the metal reinforcing with a different tool than that employed for cutting into the concrete and the separate operation involved presents no disadvantage from the standpoint of craft practice. Once the reinforcing has been cut through, the severed ends do not interfere with further concrete drilling provided that direct contact of the drill head with the ends does not occur and thus result in unwanted operation of the immobilizing circuit.

In some of the older buildings a 3-wire power system may not exist; however, the circuit of this invention is adapted to use in such cases by providing a ground wire 36 which may be clamped or otherwise firmly attached in electrically conductive relationship to any convenient electrical ground, such as a water pipe, radiator or other fixture of the building, there being no other change in either the circuit or its operation. In this connection, conventional adapters are commercially available for accommodating three-pronged plugs, such as 33, for attachment with two-recessed receptacles of 2-wire power systems.

It will be understood that the apparatus of this invention is capable of relatively wide modification as regards the circuit elements, the layout of the circuit and in other particulars, wherefor it is intended to be limited only by the scope of the following claims.

What is claimed is:

1. A concrete tool immobilizing circuit comprising an electrical relay connected in control relationship with the means powering said tool, said relay being provided with a first pair of normally closed contacts and a second pair of normally open contacts, and a current source connected at one terminal to one side of the coil of said relay and at the other terminal to ground, one of said first pair of contacts being connected to an electrical power lead and the other of said first pair of contacts being connected in control relationship to said means powering said tool, and one of said second pair of contacts being connected to electrical ground and the other of said second pair of contacts being connected to the other side of said relay coil, and electrically conductive means connected between said last-mentioned relay contact and the working head of said tool.

2. A concrete tool immobilizing circuit for an electrically driven tool comprising an electrical relay having two pairs of contacts the first pair of which is normally open and the second pair of which is normally closed, said second pair of contacts being connected in control relationship in circuit between the power supply for said tool and the motor powering said tool, a current source connected at one terminal to one side of the coil of said relay and at the other terminal to ground, one of said first pair of contacts being connected to electrical ground and the other of said first pair of contacts being connected to the other side of the coil of said relay, and electrically conductive means connected between said last-mentioned relay contact and the working head of said tool.

3. A concrete tool immobilizing circuit for an electrically driven tool comprising an electrical relay having four pairs of contacts, the first and third pairs of which are normally closed and the second and fourth pairs of which are normally open, a three-wire powering circuit for said tool consisting of a power, ground and neutral leads, a current source connected at one terminal to one side of the coil of said relay and at the other terminal to ground, said first pair of relay contacts being connected in series relationship with an electrical safe operating indication device between the power supply side of said relay coil and said ground lead, said second pair of relay contacts being connected between the other side of said relay coil and said ground lead, said third pair of relay contacts being connected in circuit between said power lead and the motor driving said tool, and said fourth pair of relay contacts being connected in series relationship with an electrical unsafe operating indication device between said power lead and said neutral lead, and electrically conductive means connected between said other side of said relay coil and the working head of said tool.

4. A concrete tool immobilizing circuit for an electrically driven tool according to claim 3 in which said electrical relay has an overlapping operational characteristic, in that said second and fourth pairs of relay contacts close in advance of the opening of said first and third pairs of relay contacts.

5. A concrete tool immobilizing circuit for an electrically driven tool according to claim 3 in which said current source comprises a transformer having its primary winding connected between said power and neutral leads and its secondary winding connected between the power input side of said relay coil and said ground lead.

References Cited in the file of this patent

UNITED STATES PATENTS

527,988 Hunter ---------- Oct. 23, 1894